## REMARKS

By this amendment, claims 2-5 and 7-9 have been amended and claims 26 and 27 have been added. Accordingly, claims 1-27 are pending in the present application. The claims have been amended to correct typographical errors, with no new matter being added. The specification has been amended to correct typographical errors and to update the priority data. Accordingly, favorable reconsideration of the pending claims is respectfully requested.

1. Rejections Under the Judicially Created Doctrine of Double Patenting

Claims 1-25 have been rejected under the judicially created doctrine of obviousness-type double patenting over claims 1-46 of U.S. Patent No. 6,150,257 to Yin et al. for the reasons set forth on page 2 of the Office Action.

This rejection will be addressed when allowable subject mater has been indicated by the Examiner.

2. Rejections Under 35 U.S.C. §103

Claims 1, 2, and 5-25 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,529,954 to Iijima et al. (hereinafter "*Iijima*") taken with U.S. Patent No. 5,633,200 to Hu (hereinafter "*Hu*") for the reasons set forth on pages 3-4 of the Office Action. Applicants respectfully traverse.

Independent claims 1 and 6 of the present application recite: (1) "reacting a chemical composition with at least one monolayer of said upper surface"; and (2) "said second dielectric layer is adhered to said electrically conductive film." Thus, although the chemical composition reacts with the upper surface of the electrically conductive film , it does not create

a layer that permanently separates the electrically conductive film from the second dielectric layer. For example, in some embodiments of the invention reacting the chemical composition with the upper surface creates a passivation layer that is substantially absorbed by the overlying dielectric layer. *See*, Specification at page 12, line 25 to page 13, line 1. In other embodiments the passivation layer is sufficiently thick to resist formation of an oxide husk, yet does not prevent the second dielectric layer from adhering to the second electrically conductive film. *Id.*

*Iijima* fails to teach or suggest these limitations. *Iijima* discloses several materials that can be formed on the upper surface of an electrically conductive film, including: a $TiO_2$ oxide layer (column 8, lines 45-50), a TiN layer (column 10, lines 30-36), and an $MgN_x$ layer (column 15, lines 50-54). However, each of these layers is distinct from the underlying electrically conductive film (Ag, Ag, and Cu w/10% Mg, respectively). Thus, *Iijima* is not reacting a chemical composition with at least one monolayer of an upper surface of an electrically conductive film, but is reacting a chemical composition with a chemical (Ti) that is diffused through the electrically conductive film to the surface of the film (*Iijima* at column 8, lines 52-54) or a chemical (Mg) that is a small component of the electrically conductive film (*Iijima* at column 15, lines 30-56). In addition, because the $TiO_2$, TiN, and $MgN_x$ layers are in between the second dielectric layer and the electrically conductive film, it is an impossible for the second dielectric layer to adhere to the electrically conductive film without performing additional steps not required by the present invention.

With regard to *Hu*, *Hu* performs his invention in exactly the opposite order to *Iijima* by building a stack instead of filling a depression. *Iijima* forms a depression that is to be filled with electrically conductive material. *Hu* builds an electrically conductive stack that is to be

buried and later exposed. Where *Hu* would use his stack as an interconnect, *Hu* must cover the stack after it has been constructed, and then some sort of topology reduction, such as CMP or etchback, would be required to expose a film in the stack that is electrically conductive. Hence, there is no suggestion in *Iijima* to combine its teachings with *Hu* because their methods proceed in opposite order.

Additionally, the combination of *Iijima* with *Hu* does not lead to an expectation of success that the claimed invention will be achieved because the anneal conditions are incompatible. *Iijima*'s anneal ranges are 450-750 °C (*Iijima* at column 6, lines 19-20) and 30 minutes (*see e.g.*, *Iijima* at column 8, lines 47-59 and column 15, lines 43-46). An anneal that lasts 30 minutes is decidedly not a rapid thermal anneal. In contrast, *Hu* uses a rapid thermal anneal (*Hu*, column 8, lines 5-10). Therefore, because of the unpredictable nature of chemical practice and the disparate results that arise from such incompatible anneals, one skilled in the art would not combine *Iijima's* 30 minute anneal process with *Hu*'s rapid anneal process. In fact, *Iijima's* 30-minute anneal applied to *Hu* would destroy the invention of *Hu* and the rapid thermal anneal of *Hu* would destroy the invention of *Iijima*. Further, where *Hu* teaches a temperature as low as 400 °C at his absolute lowest, he requires that "a high quality atomic nitrogen environment be maintained." (*Hu* at column 9, lines 23-26). Such specialized conditions cannot be combined with a 30-minute anneal.

Regarding the limitations of claim 6 of forming a passivation layer, as claimed and as further defined in the present application, *Iijima* and *Hu* are devoid of any teaching related to a passivation layer that leads to an unoxidized electrically conductive film that is adhered to by a second dielectric layer over the electrically conductive film. In addition, claims 6, 12, 15, 20, and 23 also recite some form of the limitation that the passivation layer has "a thickness not

greater than about 50 Å upon the upper surface" and claim 7 recites that the passivation layer has "a thickness in a range from about 2 Å to about 20 Å." Because neither *Iijima* nor *Hu* are concerned with forming a passivation layer as described hereinabove, let alone one having a thickness less than about 50 Å or from about 2 Å to about 20 Å, *Iijima* and *Hu* fail to teach or suggest the limitations of claims 6, 7, 12, 15, 20, and 23. *Compare, Iijima* at column 11, lines 13-15 (150 Å) and *Hu* at column 9, lines 46-50 (100 nm).

Regarding claim 13, 16, 21, and 24, *Iijima* and *Hu* do not teach or suggest multiple passivation layers, let alone a first passivation layer comprising a tungsten nitride film and a second passivation layer comprising ammonia and its derivatives that is adsorbed onto the first passivation layer. Regarding claims 14, 17, and 22, 25 *Iijima* and *Hu* do not teach or suggest that the passivation layer is adsorbed onto the electrically conductive film.

Therefore, the combination of *Iijima* with *Hu* fail to teach or suggest the limitations of claims 1, 2, and 5-25, and the withdrawal of this rejection is respectfully requested.

Claims 3 and 4 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over *Iijima* taken with *Hu* and further in view of U.S. Patent No. 5,592,024 to Aoyama et al. (hereinafter "*Aoyama*") for the reasons set forth on page 3 of the Office Action. Applicants respectfully traverse.

Claims 3 and 4 depend from claim 1 and thus include the limitations thereof, including the specific limitations of "reacting a chemical composition with at least one monolayer of said upper surface" and "said second dielectric layer is adhered to said electrically conductive film." In addition to being absent from *Iijima* and *Hu*, such limitations are also not taught or suggested in *Aoyama*. Thus, even if the cited references are combined as suggested by the Examiner, not all of the claim limitations are met.

Additionally, *Aoyama* does nothing to suggest an expectation of success in the situ limitation of claim 3 of "*in situ* depositing said second dielectric upper layer over said electrically conductive film and said first dielectric upper layer while *simultaneously* reacting said chemical composition with at least one monolayer of said upper surface." (emphasis added). This is because the insulating film (second dielectric upper layer) of *Aoyama* is generally an oxide and one skilled in the art would expect that it would protect the electrically conductive film by forming an oxide film thereover, thus preventing any reacting. The oxide film would also be expected to prevent adhesion of the insulating film to the second dielectric layer. In fact, *Aoyama* clearly shows that nitrogen plasma treatment chamber 828 and insulating film forming chamber 829 are distinct chambers that cannot simultaneously operate in the way presently claimed. *See*, Figure 35 and column 29, lines 40-44. Hence, the "simultaneous" deposition and reactions recited in claim 3 are not taught or suggested by *Aoyama*.

Therefore, the combination of *Iijima* and *Hu* with *Aoyama* fail to teach or suggest the limitations of claims 3 and 4, and the withdrawal of this rejection is respectfully requested.

Accordingly, Applicants therefore respectfully request that the rejection of claims 1-25 under 35 U.S.C. § 103(a) be withdrawn.

3. New Claims

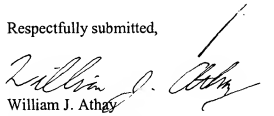
New claims 26 and 27 recite the chemical composition comprising a nitrogen-containing silane. Support for this limitation in the new claims can be found on page 12, lines 22-23 of the specification. There is no teaching or suggestion in the cited references of such a claimed feature. Accordingly, claims 26 and 27 also present patentable subject matter.

## CONCLUSION

In view of the foregoing, Applicants respectfully request favorable reconsideration and allowance of the present claims. In the event the Examiner finds any remaining impediment to the prompt allowance of this application that could be clarified by a telephone interview, the Examiner is respectfully requested to contact the undersigned attorney.

Dated this 13th day of February 2002.

Respectfully submitted,



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## VERSION WITH MARKINGS SHOWING THE CHANGES MADE

**In the specification:**

The paragraph beginning at page 2, line 2 has been amended as follows:

This is a continuation of US Patent Application Serial No. 09/143,289, filed on August 28, 1998, now U.S. Patent No. 6,150,257, titled "Plasma Treatment of an Interconnect Surface During Formation of an Interlayer Dielectric," ["PLASMA TREATMENT OF AN INTERCONNECT SURFACE DURING FORMATION OF AN INTERLAYER DIELECTRIC ",] which is incorporated herein by reference.

The paragraph beginning at page 9, line 11 has been amended as follows:

In reference to Figure 2, prevention or reduction of the likelihood of oxidation of upper surface 16 of interconnect 12 is accomplished during the formation of ILD layer 18. This is carried out by an in situ passivation of upper surface 16 of interconnect 12, immediately prior to or simultaneously with the formation of ILD layer 18, that avoids the problems of the prior art.

The paragraph beginning at page 10, line 4 has been amended as follows:

The chemical compound is provided in an amount sufficient to substantially chemically cover upper surface 16 of interconnect 12 in order to chemically protect approximately the first 1-1,000 atomic lattice layers thereof. The chemical compound may be a nitride form of the metal of which interconnect 12 is composed. Where ammonia, a hydrated nitrogen compound or the like is used, a chemical structure such as M-N-Hx forms, where M represents the metal of which interconnect 12, is composed.

**In the claims:**

Claims 2-5 and 7-9 have been amended as follows:

2. The method as defined [define] in Claim 1, wherein reacting a chemical composition with at least one monolayer of said upper surface comprises:

providing a nitrogen-containing composition;

heating said first dielectric upper layer; and

exposing said upper surface to said nitrogen-containing composition to form a chemical reaction compound having a higher resistance to oxidation than said electrically conductive film.

3. The method as defined [define] in Claim 1, wherein forming a second dielectric upper layer over said electrically conductive film and said first dielectric upper layer comprises *in situ* depositing said second dielectric upper layer over said electrically conductive film and said first dielectric upper layer while simultaneously reacting said chemical composition with at least one monolayer of said upper surface.

4. The method as defined [define] in Claim 1, wherein forming a second dielectric upper layer over said electrically conductive film and said first dielectric upper layer comprises *in situ* depositing said second dielectric upper layer over said electrically conductive film and said first dielectric upper layer after reacting said chemical composition with at least one monolayer of said upper surface.

5. The method as defined [define] in Claim 1, wherein reacting said chemical composition with at least one monolayer of said upper surface forms a passivation layer upon said upper surface of said electrically conductive film.

7. The method as defined [define] in Claim 6, wherein the passivation layer upon the upper surface has a thickness in a range from about 2 Å to about 20 Å.

8. The method as defined [define] in Claim 6, wherein reacting said chemical composition with said at least one monolayer comprises forming a passivation layer upon said upper surface that is adsorbed onto said at least one monolayer.

9. The method as defined [define] in Claim 6, wherein said passivation layer is formed by the steps comprising:

forming a first layer by chemically reacting components of said chemical composition and said at least one monolayer; and

forming a second layer by adsorbing portions of said chemical composition onto said first layer.